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An Investigation of Damage in SiC/Titanium Using the Scanning Acoustic Microscope

Final Report

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SAM Final Report
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The V.G. Semicon ASM 100 scanning acoustic microscope has been under investigation for the past 17 months with the goal of upgrading it's use to investigate SCS-6 fibers of approximately 120 microns in diameter used to reinforce a titanium MMC similar to the work performed by Rich Klassen of G.E. Using samples provided by Pete Kantzos initial scans at approximately 38 MHz proved unsatisfactory. Though visible there was little about the condition of the fibers or their interface that would prove of interest or use to this branch.

After visits to Wright Patterson AFB and the G.E. lab in Dayton and a literature search it was determined that more information from the manufacturer was necessary to properly evaluate the systems potential. This proved fruitless until contact was established with a former engineer from V.G. , Dr. Ian Smith, currently of Park Scientific Instruments in Sunnyvale, CA.

In November 1992 Dr Smith made a two day trip to NASA to fine tune the system and help evaluate it's potential. During this visit some corrections were made but other problems with transducer impedance matching and overall electronic performance were discovered. These were responsible, as well as the operating frequency, for a pulse that was too long, 200 ns, and too weak to resolve fibers in the desired composites.

Efforts to locate more efficient transducers and to upgrade the systems electronics were undertaken. It was decided after some investigation to use an in house Panametrics 100 MHz lens and to ship the needed electronics out to Dr. Smith for the upgrade. Since the low frequency boards modification and return a final evaluation has been undertaken. It is Dr. Smiths opinion that the electronics are performing as well as can be expected. Additional modifications by myself and Dave Newman have apparently maximized the current signal from this unit at this frequency.

The current signal using the modified board, see attached for details, and the Panametrics lens has still failed to sufficiently resolve these fibers in the MMC (see attached scan). A front surface reflection in the neighborhood of 50 ns or less would be required for this application. The current signal, while improved, still falls significanly short of this value. Last measured it was approximately 150 ns. At this point the second part of the upgrade, additional transducers, has been suggested by Dr. Smith as the next logical step. The 100 MHz Panametrics is insufficient for this unit. It's bandwidth appearts to be in the neighborhood of 40 MHz. A lens at that frequency for this unit would require a bandwidth of 80 to 90 MHz to reduce the signal length to a usable pulse. A more sensitive Panametrics 90 MHz or perhaps an Ultran 100 MHz have been recommended. Information on these lenses has been referenced in the past correspondence from Dr. Smith. Decisions as to the next step with this unit should keep in mind his recommendations on these lenses as well as his overall optimism for this system.

In general, however, the goals of this upgrade have yet to be reached. While some progress and much learning has taken place this unit still falls short of what was expected. The transducers would be the next step in that direction but no guarantees appear to come with it. Until the question of initial pulse lenngth is answered satifactorily the goals for this system cannot be met.

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Report on ASM-100 modifications

1. Goal

Modify and adjust ASM-100 electronics to obtain the best sensitivity possible using a 100MHz Panametrics Acoustic lens.

2. Circuit modifications

a) When using the 100MHz lens *do not* connect the attenuator between the lens and electronics. Rather, connect the lens directly to the electronics. This is worth 1-2dB. The attenuator should be used with the 100MHz lens for surface imaging, where signal levels are now high, and with the 60MHz lens at all times.

b) CV1 increased to 120pF, C51 to 2000pF and R29 eliminated. This gave a worthwhile improvement in signal strength on the 100MHz lens, through improved electrical matching to the transducer. A diode pulse limiter circuit was experimented with in order to reduce pulse saturation issues, but turned out not to be necessary since the AD844 pulse amplifier circuit recovers quickly from saturation.

c) Added AD844 pulse amplifier circuit. This is a 30MHz non-inverting voltage amplifier with saturation limits close to the +/-15v supply rail. Since the previous stages have saturation limits at approximately 2v this is a worthwhile increase in dynamic range. The gain as shipped is set to about 21x.

3. Results

Originally only the first reflection from the lens surface on the 100MHz lens could be detected. As modified four "buffer-rod" echoes are detectable, and the first is fully saturated at +15v. The surface reflection from a coin now measures +14.5v, a major improvement. Using a thin sheet of acrylic it was possible to resolve front and backside echoes, although the 100MHz lens is not well designed for subsurface imaging.

System gain and sensitivity levels are now so high that the 60MHz lens requires significant attenuation in order to operate.

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4. Modifications pending

a) The video Butterworth filter networks were not modified since only a 10MHz oscilloscope was available and it was not possible to measure the actual bandwidth of the system. If on inspection a wider video bandwidth is desired in order to permit shorter pulse durations the the components L1, C61 and C62 should be appropriately scaled e.g. for 20MHz bandwidth these component values should be halved.

b) The time constant components C35 and C37 may need reduction for the shorter pulse lengths. Values around half current may be useful, but require testing in-situ for optimisation.

5. Lenses

a) Panametrics 100MHz lens

The insertion loss is extremely high, as can be seen by comparison with the 60MHz lens.... neither lens has an impedance matching network, raising doubts about the quality or integrity of the Panametrics lens. It might be worthwhile sending it back to the manufacturer for testing.

b) ASM 60MHz lens

Studying this lens further, it is obvious that the lens has been incorrectly built. The cut-back surrounding the lens is too steep, and comes too close to the lens surface, resulting in time dispersion of echoes within the buffer rod and giving rise to the background signals which interfere with pulses reflected by the sample. A much cleaner lens could be created without the cut-back if that were desirable

6. Conclusions

The next task is to reassemble the microscope and test the 100MHz lens on samples of interest. Depending on the pulse lengths achieved further component modifications may be necessary although these should be accomplished without side effects. It is felt that there is only limited scope for further sensitivity improvement of the existing electronics; the major limitation in subsurface imaging potential appears to be the 100MHz lens itself.

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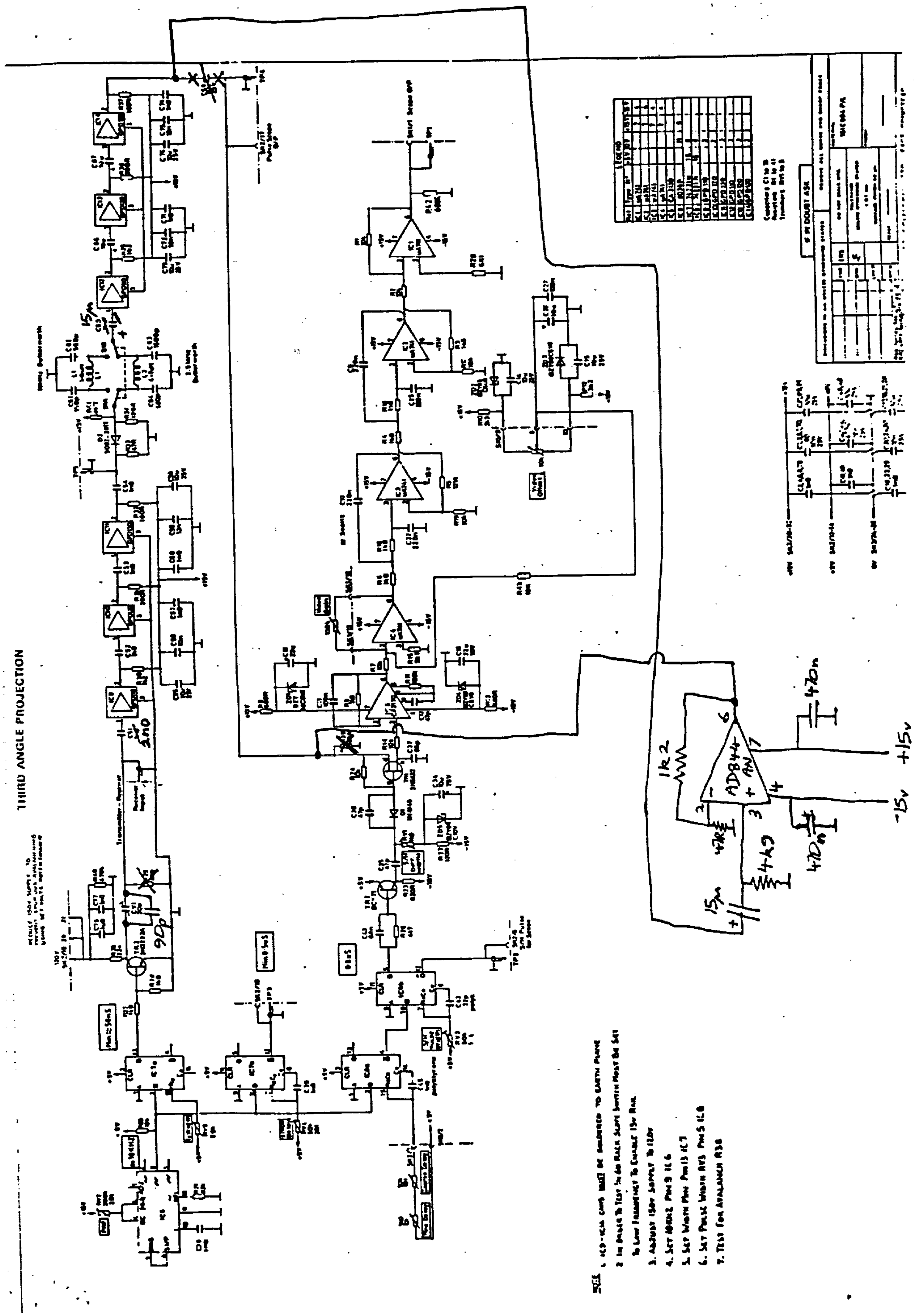

100MHz version
As modified for NASA Lewis
IRS 5/10/93